

**10031**  
Vitrophyre Basalt  
2.7 grams



*Figure 1: Photo of 10031. Scale 1.8 cm. NASA S76-21144.*

**Introduction**

10031 was returned as a “contingency sample”. It is apparently a quickly cooled (quenched) example of the high-K ilmenite basalts from Apollo 11.

It is 3.6 b.y. old and has had an exposure to cosmic rays for ~ 300 m.y.

**Petrography**

Beaty et al. (1979) describe 10031 as a “vitrophyre”. Phenocrysts of olivine and armalcolite (with ilmenite overgrowth) are contained in a fine-grained to glassy groundmass. *“10031 contains about 60% crystals which consist of equant armalcolite mantled by rutile-bearing ilmenite, platy ilmenite (50 x 5 microns) with feathery edges, pyroxene (to 100 microns) and minute troilite spheres. These crystals are enclosed in a brown glass which contains numerous incipient crystallites of ilmenite and pyroxene.”* (from Beaty et al.)

Grove and Beaty (1980) were able to reproduce the texture of 10031 experimentally and determine the cooling rate.

**Mineralogy**

***Olivine:*** Olivine is Fo<sub>75</sub>.

***Pyroxene:*** Beaty et al. give the composition of some pyroxene grains.

***Armalcolite:*** The composition of armalcolite in 10031 is discussed in Beaty et al.

***Ilmenite:*** Ilmenite in 10031 forms elongate platy grains (figure 2) and also forms overgrowths on armalcolite grains and has exsolution of rutile.

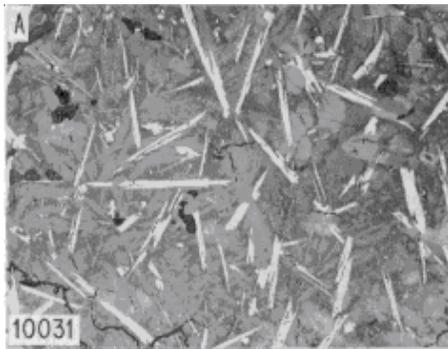


Figure 2: Texture of 10031 from Beaty et al. 1979.

### Chemistry

Lunar sample 10031 has the composition typical of the high-K suite of Apollo 11 basalts (table 1).

### Radiogenic age dating

Guggisberg et al. (1979) determined the age of 10031 by the Ar/Ar plateau technique (figure 3).

### Cosmogenic isotopes and exposure ages

Guggisberg et al. (1979) determined an  $^{37}\text{Ar}/^{38}\text{Ar}$  exposure age of 300 m.y. There are 2 thin sections.

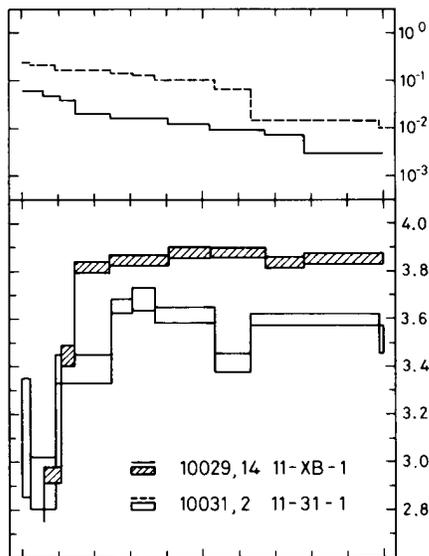


Figure 3: Argon plateau for 10031 compared with 10029 (from Guggisberg et al. 1979).

### Summary of Age Data for 10031

Guggisberg et al. 1979      Ar/Ar  
 $3.6 \pm 0.08$  b.y. (poorly defined)

Table 1. Chemical composition of 10031.

reference weight	Beaty 1979	
SiO <sub>2</sub> %		
TiO <sub>2</sub>	11.4	(a)
Al <sub>2</sub> O <sub>3</sub>	8	(a)
FeO	20.7	(a)
MnO	0.225	(a)
MgO	8	(a)
CaO	10.6	(a)
Na <sub>2</sub> O	0.503	(a)
K <sub>2</sub> O	0.3	(a)
P <sub>2</sub> O <sub>5</sub>		
S %		
sum		
Sc ppm	87	(a)
V	65	(a)
Cr	2370	(a)
Co	28	(a)
Ni		
Cu		
Zn		
Ga		
Ge ppb		
As		
Se		
Rb		
Sr		
Y		
Zr	370	(a)
Nb		
Mo		
Ru		
Rh		
Pd ppb		
Ag ppb		
Cd ppb		
In ppb		
Sn ppb		
Sb ppb		
Te ppb		
Cs ppm		
Ba	330	(a)
La	27.3	(a)
Ce	78	(a)
Pr		
Nd	64	(a)
Sm	20.7	(a)
Eu	2.23	(a)
Gd		
Tb	4.3	(a)
Dy	30	(a)
Ho		
Er		
Tm		
Yb	17.2	(a)
Lu	2.43	(a)
Hf	15.4	(a)
Ta	2.5	(a)
W ppb		
Re ppb		
Os ppb		
Ir ppb		
Pt ppb		
Au ppb		
Th ppm	2.8	(a)
U ppm		

technique: (a) INAA

## References for 10031

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Grove T.L. and Beaty D.W. (1980) Classification, experimental petrology and possible volcanic histories of the Apollo 11 high-K basalts. *Proc. 11<sup>th</sup> Lunar Planet. Sci. Conf.* 149-177.

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